Unit Title:
Grades 3-5: Total Solar Eclipse Phenomena
Standards http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf
The solar eclipse phenomena finds direct correlation to 4th grade Earth Science and Physical Science standards. However, Third grade and Fifth grade teachers are encouraged to use these resources below to teach their students about the unusual phenomenon that is occurring across our state, a total solar eclipse. It is important that all students, regardless of grade, be prepared for this amazing science phenomenon preceding the event on August 21, 2017. The information below begins with the overall learning needed for all 3-5 students and then continues with deeper extension activities designed to enhance interest in, understanding of, and appreciation for this once in a lifetime event. **3rd Grade:** Standard 3.P.2: The student will demonstrate an understanding of the properties used to classify matter and how heat energy can change matter from one state to another. **4th Grade:** Standard 4.E.3: The student will demonstrate an understanding of the locations, movements, and patterns of stars and objects in the solar system. Standard 4.P.4: The student will demonstrate an understanding of the properties of light and sound as forms of energy. **5th Grade:** Standard 5.P.5: The student will demonstrate an understanding of the factors that affect the motion of an object.

New Academic Vocabulary **Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.**					
Eclipse	Eye safety	Light energy	Motion	Opaque	Shadow

Prior Knowledge
• 1.E.3A.3 – Basic knowledge of how technology helps humans study the sun, moon, and stars • 1.E.3A.4 – Effect of sunlight on Earth's surface. • 1.E.3 – Motion of the moon across the night sky • 1.P.2A.3 – Shadows change when the light source changes position • 1P.2A.2 – Light behavior when shined on an object • 4.E.3B.1 – Patterns in the location, movement, and appearance of the moon • 4.E.3B.3 – Shadow observations
Subsequent Knowledge
• 8.E.4B.5 – Technology helps provide information about objects in the solar system and universe. • 8.E.4 – Observable physical characteristics of the moon • 8.E.4B.4 – Interactions between the sun, moon, and earth cause earth phenomena • H.E.2 – Technical composition of the moon and its orbit in relation to other moons in the solar system • HE.2A.5 – Advanced telescopes and computer modeling helps explore the universe. • H.P.3F.2 – Interaction between visible light and objects

Teacher Background Information on Solar Eclipse
• General background information for teachers on solar eclipses: http://www.mreclipse.com/Special/SEprimer.html • An Observer's Guide to Viewing the All-American Total Solar Eclipse provided by NSTA: http://static.nsta.org/extras/solarscience/SolarScienceInsert.pdf • A short video that explains the three types of solar eclipses: https://www.youtube.com/watch?v=is8OLhGgLAE

Possible Instructional Strategies/Lessons: **Strategies and lessons that will enable students to master the standard and/or indicator.**
1. Eye Safety **Essential Question: How can I safely watch the entire total solar eclipse?** • Eye safety information: All students should receive careful instruction in this area. Concerns for eye safety during a total solar eclipse provided by NASA can be found using this link: https://eclipse.gsfc.nasa.gov/SEhelp/safety.html.

- Information concerning the importance of eye safety, brands of viewers that are available for sale, and the standards they must meet: https://eclipse.aas.org/eye-safety/iso-certification

2. Exploration of a Total Solar Eclipse

A. Possible Introductory Activities Through Asking Questions and Defining Problems. *Choose from the following bulleted items to elicit student thinking about total solar eclipses through asking questions. Science begins with questions about phenomena, seeking to gather the evidence necessary to construct an explanation about the phenomena. Asking questions leads towards inquiry and drives science and engineering. It is an essential practice to developing scientific habits of mind. These questions are driven by curiosity, by the desire to understand a phenomenon, or by the need to solve a problem. In science, a question should always lead to an investigation to acquire the necessary evidence in an attempt to answer that question.*

Essential Question: Why will there be darkness during the day on August 21, 2017?

- **Weather Satellite Video of a Total Solar Eclipse:** Prompt student thinking about eclipses and what causes them by showing a time-lapse video that recorded a total solar eclipse passing over the Pacific Ocean. To enhance student discussion, the teacher should not reveal any information about the video. Before viewing, tell students that they will be asked to share one thing about the video and explain why this thing caught his/her interest. Once all students have shared, ask students to share questions that they think of while watching the clip. Encourage students to share some possible answers to the questions. Allow the discussion to be student-driven. Do not yet explain to students what they are observing at this point. Because the video is very short, the teacher may need to replay it multiple times as the discussion progresses. At the Digital Typhoon: Total Solar Eclipse of March 9, 2016 website, find the "Animation" header and click on the "RGB" link below it to view the video (http://agora.ex.nii.ac.jp/digital-typhoon/solar-eclipse/20160309/).
- **Deep Space Climate Observatory (DSCOVR) Animation of the Moon Crossing the Face of the Earth:** After viewing the weather satellite video of a total solar eclipse and holding discussions about the phenomena, have students watch this animation of the moon crossing the face of the earth. Prompt student ideas by asking these questions: 1. What do you notice? 2. What questions do you have? 3. What do you think is happening? 4. How are these images related to the ones we watched earlier? 5. What might be the relationship between what we have observed in the

different videos? It is very important that the teacher not reveal the "right" answers during this discussion and that the students are given the opportunity to safely share their thinking and answers with each other (https://www.nasa.gov/feature/goddard/from-a-million-miles-away-nasa-camera-shows-moon-crossing-face-of-earth).

- **Time-lapse video from Iceland:** After viewing the weather satellite and videos, have students view videos of a total solar eclipse from the surface of the earth. Some students may, by this time, have come to the conclusion that the phenomenon being observed in all videos and images is a total solar eclipse. If they have not, inform students that the phenomena they have been watching is a total solar eclipse and explain briefly that the moon moves between the sun and the earth which blocks the light causing a shadow on the earth. Students will observe a time-lapse video of a total solar eclipse from Iceland. Again, ask students these questions: 1. What do you notice? 2. What questions do you have? 3. What do you think is happening? 4. How are these images related to the ones we watched earlier? 5. What might be the relationship between what we have observed in the different videos?
  Iceland video: https://www.youtube.com/watch?v=ZAxl0S7za8I

Literary techniques to support learning goals: *Teachers may choose from the following literary techniques below that will assist in learning through asking questions about the total solar eclipse and transacting with text. These techniques can be used before, during, or after any guided content.*

1. **Interactive Read Aloud** *(Burkins, 2012): This technique can be used to engage students with text in meaningful ways. After selecting the text, construct open-ended questions that support thoughtful discussion. Some example questions that the teachers could ask while reading include:*

- *What will happen next?*
- *What are you thinking right now?*
- *This reminds me of _____. What does it remind you of?*
- *What picture do you see in your mind right now? What does this make you wonder about?*
- *How is this story like other stories we have read/heard?*

After reading, students can illustrate the main idea of the text, create their own questions about the text (to be posted and answered throughout the unit), and/or share with a partner new learning from the text and what else they may wonder.

2. **Close Reading** *(Beers and Probst, 2012): Using this technique, the teacher takes the students through reading a text*

multiple times for a purpose in order to get to analysis of the text.

- *The text is read the first time to get the gist of the text (What is the main idea and how do you know?).*
- *The text is read a second time to gain understanding. Here the text can be annotated with a "?" for words or phrases students do not know or understand. Students will use an "!" for information students found interesting. After reading, students can share annotations with a partner to help each other identify words/phrases for meaning and share why they found the designated information interesting. Students may then share with the whole group.*
- *The text is read a third time to determine what the text is not saying (making inferences). The teacher models making inferences by:*
  - *From the text clues, I can conclude that...*
  - *Based on what the text says and what I know, I think . . .*
  - *This information makes me think . . .*
- *After the last read, pull all of the information gained to revisit the question: "What is the main idea and how do we know?"*

  Note: Teachers may modify for age appropriateness.

Choose from the following resources to support student engagement with the total solar eclipse and transaction with text.

Literary texts:

- Eclipse: Darkness in the Daytime by Franklin Branley. This book gives a simple description of solar eclipses. It also includes the best methods to view them and how astronomers study them.
- Where Did the Sun Go? Myths and Legends of Solar Eclipses Around the World Told with Poetry and Puppetry by Janet Cameron Hoult. This book may provide examples from which students can create their own myths.
- The Moon Book by Gail Gibbons. This book provides information about moon phases, eclipses, and lunar explorations.
- Eclipses (The Night Sky: and Other Amazing Sights in Space) by Nick Hunter. This book provides information about the sun, moon and our planet. It explains what eclipses are, what they look like, how they happen, and their effects on wildlife.
- The Big Eclipse by Nancy Coffelt. This book introduces a cast of charming animal characters as they follow the path of the 2017 eclipse across America, capturing their sense of wonder and excitement. Readers will learn what causes eclipses, about strange eclipse effects, eclipse myths and even learn what hippos do when day turns to night. The book tells why it's important to protect your eyes when viewing the sun, especially during an eclipse – and how to do

so safely. Each book comes with a safe solar eclipse viewer. Note: If you like this book, you may also like The Big Eclipse Activity Book - 24 pages of eclipse and science activities.

- Sun Moon Earth: The History of Solar Eclipses from omens of Doom to Einstein and Exoplanets by Tyler Nordgren. In this book, astronomer Tyler Nordgren illustrates how this most seemingly unnatural of natural phenomena was transformed from a fearsome omen to a tourist attraction.

Videos and other resources:

- Brainpop Jr. Videos:
  Note: Individuals may obtain a username and password by contacting their local or school library, calling the SC State Library at (803) 545-0210, or emailing Discusoffice@statelibrary.sc.gov.
  - https://jr.brainpop.com/science/space/solarsystem/ (Solar System)
- You Tube Videos:
  - https://www.youtube.com/watch?v=is8OLhGgLAE (What is the solar eclipse?-3 types of eclipses)
  - https://www.youtube.com/watch?v=E6OtLfszaVI (solar eclipse explained)
- The following website provides a simplified explanation of lunar and solar eclipses from NASA: https://spaceplace.nasa.gov/eclipses/en/
- A Promethean Planet (Class Flow) presentation titled Solar Eclipse by Amanda Neumann explains and shows what happens during a solar eclipse to help students visualize the process taking place. Use the search tool and enter Amanda Neumann. https://classflow.com/classflow/#!/product/itemId=146f7b8431f648d7ad5c3dd6e8b905ee

B. Total Solar Eclipse Exploration Through Modeling: *Teachers may choose from the following bulleted options that will assist in learning through modeling and the total solar eclipse. The Science and Engineering Practice of developing and using models is used to understand and represent the total solar eclipse phenomena, processes, and relationships. Models may serve as a way to answer scientific questions asked above by students. Below you will find multiple modeling strategies to choose from to engage your students in this SEP while learning about the total solar eclipse phenomena. Each student should have the opportunity to participate in at least one of these structured investigations to model a total solar eclipse.*

Essential Question: How can I model what happens during a Total Solar Eclipse?

- Here is a whole class activity to develop a model to observe what occurs during a solar eclipse. Materials required include a globe, Styrofoam ball, string or line, lamp or light source, and some type of hook.

http://www.eyeonthesky.org/lessonplans/11sun_eclipseclass.html

- This website provides an activity in which students can simulate an eclipse using different size spheres and a light source. http://www.eclipse.aaq.org.au/index.php/classroom-activities/eclipse-activities
- Students will review the phases of the moon and then work in collaborative groups to try and make an eclipse occur while they investigate why eclipses occur.
  http://www.lpi.usra.edu/education/other_programs/lunar_eclipse/fruit_loops.shtml

C. Total Solar Eclipse Exploration Through Analyzing and Interpreting Data *Teachers may choose from the following bulleted options that will assist learning through analyzing and interpreting data and the total solar eclipse. The Science and Engineering Practice of analyzing and interpreting data is used to understand what occurs during the total solar eclipse phenomena. Analysis and interpretation of data may serve as a way to answer scientific questions asked by students. Below you will find activities that will engage students in the collection and analysis of data while learning about the total solar eclipse phenomena. Each student should have the opportunity to participate in the collection and analysis of data while participating in a structured investigation.*

Essential Question: How does the size difference between the sun, moon, and earth and the relative distances between them, result in the total solar eclipse?

- *How Can the Little Moon Hide the Giant Sun?* Students will investigate how distance affects the appearance of an object and explain how the smaller moon can block out the much larger sun.
  http://www.eyeonthesky.org/lessonplans/12sun_littlemoon.html
  Extension: You could also have students compare the distances required for two different balls (a medium sized and a small one) to cover up the larger ball. You could also form a ratio comparing the diameters of the medium and small balls to the distance needed to block the larger ball to explore the relationship between size and distance.
- ACTIVITY 21 – 2013 Annular Eclipse in Queensland – A simulation program: This activity uses Stellarium, which is an easy download from this site. Using Stellarium and the activity, students can watch an actual solar eclipse. Students can then describe and record observations that they made during the simulation.
  http://www.eclipse.aaq.org.au/index.php/classroom-activities/eclipse-activities
  Extension: You could also have students compare the solar eclipse using a different location to compare the different simulations.

Essential Question: What can we learn from data collected during a total solar eclipse?

- *Measuring the Dimming of the Daylight*: Students can record the brightness during the solar eclipse, using one of several devices suggested in the article. Students can use the data to create graphs and construct an explanation based on the analysis of the data collected. https://eclipse2017.nasa.gov/measuring-dimming-daylight
- *Temperature Change during Totality*: Students can collect data on the temperature change during the totality of the eclipse. Students can use the data to create graphs and construct an explanation based on the analysis of the data collected. If actual data collection is not possible, use the image on the website to have students analyze the data in "The Air Temperature in Lusaka, Zambia, during the June 21, 2001, total solar eclipse". Students can analyze the data and make predictions as to what occurs during the total solar eclipse in their area on August, 21, 2017. https://eclipse2017.nasa.gov/temperature-change-during-totality

3. Possible Culminating Activities: *Teachers may choose from the following bulleted options that will focus total solar eclipse learning around constructing explanations, obtaining and evaluating data and communicating information.*

- Students will create models to communicate information learned about the total solar eclipse phenomena. Early astronomers had many misconceptions surrounding a total eclipse. Present this scenario: Students have discovered a way to send information back in time, and they have been charged to share scientific information to explain the phenomena known today as the total solar eclipse to early astronomers. Have students create a presentation of their choice to explain the processes that result in a total solar eclipse to be transmitted to the past. The presentation should include information and data obtained through research.
- Students will construct explanations to communicate learning. Student products will reflect data collected and analyzed. Students will illustrate the changes that occur during a total solar eclipse by creating a "comic strip" that shows South Carolina's exposure to the total solar eclipse. Students can be given a choice board where they can select their character (friends, animals, parents, Ancient Egyptians, etc.) and setting (chicken pen, beach, Egypt, mountains) that they will illustrate through the comic-like design. The teacher may need to investigate how to create developmentally appropriate comic strips expectations and designs. Resource for creating comic strip online individually or as a class can be found at http://www.readwritethink.org/files/resources/interactives/comic/ .
- Students will communicate information learned about the total solar eclipse. The pamphlets created will include data analysis and diagrams. Students will create an informational pamphlet about the total solar eclipse to provide information to

their community to prepare them for the event that will occur on August 21, 2017. This pamphlet will help to clear any misconceptions the public may have about the event. The pamphlet should include, explanations, safety precautions, and diagrams to explain the phenomenon.

- Students will read solar eclipse myths and legends. With teacher guidance, students can create a T-chart showing the myth elements versus factual scientific information about total solar eclipses. Students will then construct their own explanations of how a total solar eclipse occurs to someone from the era they chose. For instance after reading the Egyptian legend, they will then construct their own explanation of solar eclipse to an ancient Egyptian. The explanation should include diagrams and reflect any data obtained.
    - Read Alouds of Myths, Stories, and Historical References available at http://www.kidseclipse.com/pages/a1b3c5d0.htm .
    - Read Aloud: Where Did the Sun Go? Myths and Legends of Solar Eclipses Around the World Told with Poetry and Puppetry by Janet Cameron Hoult
    - Storytelling videos available at https://sunearthday.nasa.gov/2006/multimedia/storyteller.php.
    - There are numerous myth stories listed under teacher resources at http://thechallengercenter.net/?page_id=1768.

  As an extension, students can write their own myths describing a total solar eclipse.
- Students will construct and design their own "viewing device" for the solar eclipse. Students will present their own device and provide "how to" instructions. Students can then vote on the winning device and share the instructions for that device with students in the school and/or community. Some resources for basic viewing devices are listed below.
    - This resource provides an explanation of how the image of the sun is projected on the paper along with a brief video of one way to make a projector. The resource includes a diagram and brief history of the "technology" of projecting the light. https://eclipse2017.nasa.gov/solar-viewing-projector
    - Make a Pinhole Projector: https://www.education.com/activity/article/Pinhole_Projection/
    - Cereal Box Eclipse Viewer: http://www.hilaroad.com/camp/projects/eclipse_viewer/eclipse_viewer.html

Extension Activities

These strategies and lessons will enable students to understand the total eclipse phenomena with more direct ties to specific grade level Performance Indicators. These are designed to enhance interest in, understanding of, and appreciation for this once in a lifetime event. Performance Indicators are listed below in purple. The text within the Performance Indicators highlighted in *orange* and *italicized/underlined* shows connections to SEPs.

Note: Refer to the literary techniques shared in the previous section to facilitate learning with any literary/informational texts shared below.

Third Grade Performance Indicator:
3.P.2A.1 *Analyze and interpret data* from observations and measurements to describe and compare the physical properties of matter (including length, mass, temperature, and volume of liquids).

Exploration of the physical properties of the sun, earth, and moon.
Essential Question: How do the physical properties of the earth, sun, and moon lead to a solar eclipse?

Vocabulary: properties, solid, liquid, gas

1. **Possible introductory activities:**
   Choose from the following resources to support student engagement with the total solar eclipse and transaction with text.

   Literary texts:
   - Earth, Sun, Moon by Glen Phelan. This is a book published by National Geographic that describes the motion of the earth and moon in relation to the sun.

   Videos and other resources:
   - You Tube Videos:
     - https://www.youtube.com/watch?v=abAGUi2aG4I (Physical Properties of the Sun)
     - https://www.youtube.com/watch?v=JM21GBJecx0 (Physical Properties of the Moon)

2. Instructional Strategies: The properties of size, shape, and pattern of motion cause the moon to block the sun's light from the earth, resulting in the phenomena known as the total solar eclipse.

- This article provides information about the physical properties of the sun, earth, and moon. Students could create diagrams to compare and contrast the physical properties of the three bodies. Students could then make a presentation or write a paragraph using their diagrams to explain to younger students how they are similar and different. http://www.katyisd.org/campus/KDE/Documents/Fifth%20Grade/Earth,%20Sun,%20and%20Moon.pdf
- Students will observe and record information about the physical properties of the sun, earth, and moon. This lesson was geared toward fifth grade but could be simplified for third graders. http://www.bsisd.esc18.net/documents/Lesson%20Ideas/LESSONS%20&%20RESOURCES/SCIENCE/5th%20Gr/Science_Grade

05_Unit_07_Exemplar_Lesson_01__Comparing_the_Sun,_Earth,_and_Moon.pdf

- Students could gather information on the physical characteristics of the sun, earth, and moon and share their information in a Gallery Walk. Students can use any information gathered from previous resources. The following website has links to other sites that provide information on the properties of the sun, earth, and moon. http://superstaar.org/grade-5/earthspace/58-earth-sun-and-moon-patterns/58d-physical-characteristics-of-sun-earth-and-moon/

Fourth Grade Performance Indicator:
4.E.3A.3 *Construct scientific arguments* to support claims about the importance of astronomy in navigation and exploration (including the use of telescopes, astrolabes, compasses, and sextants).

Exploration of the Moon

Essential Question: How has astronomy and exploration enabled us to learn about the interaction between the sun and moon?

Vocabulary: technology, exploration, interaction

1. **Possible introductory activities:**
   Choose from the following resources to support student engagement with the total solar eclipse and transaction with text.

   Literary texts:
   - I Took the Moon for a Walk by Carolyn Curtis and Alison Jay. This book provides a poem that teaches fun facts about the moon.
   - Papa, Please Get the Moon for Me by Eric Carle. This book encourages students to observe changes in the moon.
   - The Moon Over Star by Dianna Hutts Aston. This book is told by a girl who witnessed the "first moon landing." The book can be used to get the students excited about the exploration of the moon.
   - The Moon by Seymour Simon. This book is a good introduction to studying the moon with NASA's photographs and texts.

   Videos and other resources:
   - *Brainpop Jr. Videos:*
     Note: Individuals may obtain a username and password by contacting their local or school library, calling the SC State Library at (803) 545-0210, or emailing Discusoffice@statelibrary.sc.gov.

- https://jr.brainpop.com/science/space/sun/ (sun)
- https://jr.brainpop.com/science/energy/light/ (light)

- National Geographic Video:
  - Moon 101 http://video.nationalgeographic.com/video/101-videos/moon-101-sci

2. Instructional Strategies: The information gathered by astronomers to learn about the solar system has resulted in a better understanding of how and why phenomena such as the total solar eclipse occurs.

- *All About the Moon* (Scholastic article): Students will read the article based on information discovered about the moon through scientific exploration. Students will make an argument (written or presentation) to justify why the exploration and study of astronomy is important to understanding factors that affect our planet. https://www.scholastic.com/teachers/articles/teaching-content/all-about-moon/
- Students can use these resources found below about the Apollo 11 space mission to research information gathered about our moon through the field of astronomy. Students can work individually or in a cooperative group to create a persuasive argument in favor of or against spending funds to further explore the moon. Students should present their argument to their classmates, write a persuasive essay, or have a debate. Students should include their thoughts on how the importance of astronomy has led to a better understanding of how and why phenomena such as the total solar eclipse occurs. https://www.nasa.gov/mission_pages/apollo/apollo11.html

4.E.3B.1 *Analyze and interpret data from observations* to describe patterns in the (1) location, (2) movement, and (3) appearance of the Moon throughout the year.

Phases of the Moon

Essential Question: How do moon phases relate to the phenomena known as a total solar eclipse?

Vocabulary: phases, new moon, full moon, waxing, waning, crescent, gibbous, first quarter, third quarter, reflection

1. **Possible introductory activities:**

Choose from the following resources to support student engagement with the total solar eclipse and transaction with text.

Literary texts:

- Faces of the Moon by Bob Crelin. This book describes the moon's phases.
- The Moon Seems to Change by Franklyn Branley. This book provides information about the phases of the moon and includes a science investigation at the end of the book to explore the moon phases.

Videos and other resources

- BrainPop Jr Video
  Note: Individuals may obtain a username and password by contacting their local public or school library, or by calling the SC State Library at (803) 545-0210, or emailing Discusoffice@statelibrary.sc.gov.
  - https://jr.brainpop.com/science/space/moon/ (Phases of the Moon)
- You Tube Videos
  - https://www.youtube.com/watch?v=NCweccNOaqo (Lunar Cycle, Why The Moon Change Shapes, 8 Phases of the Moon)
- Teacher Tube Video
  - http://www.teachertube.com/video/the-phases-of-the-moon-9797 (The Phases of the Moon)
- History Videos
  - http://www.history.com/shows/the-universe/videos/phases-of-the-moon (Phases of the Moon)

2. Instructional Strategies: The phenomena of a total solar eclipse can only occur during a new moon because the moon is located between the earth and sun. This means that no light reflected by the moon can be seen on earth.

- Paper Plate Moon Phase Activity: Students will use inexpensive paper plates to create representations of all the moon's phases. You could extend this by having students write a dialog to describe what is happening through the 29 day cycle of the moon. You may want to explore the understanding that a total solar eclipse only occurs during a new moon phase through questioning. http://www.unawe.org/activity/eu-unawe1310/
- Moon Phases Calendar: This resource can be used to determine when the phase of the moon will occur during a given month. The class can analyze the moon cycle to determine approximately how many days the moon remains in one phase before moving on to the other which could be a tie in to math with fractions and percents. You may want to explore through questioningthe understanding that a total solar eclipse only occurs during a new moon phase.
  http://www.moonconnection.com/moon_phases_calendar.phtml

4.E.3B.3 *Construct explanations* of how the Sun appears to move throughout the day using observations of shadows.
4.P.4A.5 *Plan and conduct scientific investigations* to explain how light behaves when it strikes transparent, translucent, and opaque materials.

Lights and Shadows

Essential Question: How does the interaction of light and shadows result in an eclipse viewed on earth?

Vocabulary: translucent, transparent, opaque, reflection

1. **Possible introductory activities:**
   Choose from the following resources to support student engagement with the total solar eclipse and transaction with text.

   Literary texts:
   - What Makes A Shadow? by Clyde Robert Bulla and June Otani: This book explains how shadows are made and helps students learn to make their own shadows.
   - Shadow Games by Bill Mayer: This book helps students learn to make shadows with their hands.
   - Moonbear's Shadow by Frank Asch: This book is a fictional story about a bear who is scared away by his own shadow. The bear tries to come up with different ways to escape his shadow.
   - Nothing Sticks Like A Shadow by Lynn Munsinger. This book is a fictional story of a rabbit that tries to escape his shadow to win a bet.
   - Poem - My Shadow by Robert Louis Stevenson - (A Child's Garden of Verses): This book helps students learn ways to interact with their shadows.

   Videos and other resources:
   - *Brainpop Jr. Videos:*
     Note: Individuals may obtain a username and password by contacting their local or school library, calling the SC State Library at (803) 545-0210, or emailing Discusoffice@statelibrary.sc.gov.
     - https://jr.brainpop.com/science/energy/light/ (light)
     - https://jr.brainpop.com/science/space/sun/ (sun)

2. Instructional Strategies: A total solar eclipse occurs when the moon blocks the sun's light and creates a shadow on the surface of the earth.

- *Interactive Science: The Human Sundial* : This lesson will allow students to explore how shadows change based on the position of the light source. https://www.scholastic.com/teachers/blog-posts/genia-connell/interactive-science-human-sundial/
- Students will conduct investigations to determine the effect light has on materials. Students will use different objects and flashlights to explain the behavior of light and the creation of shadows. http://www.skwirk.com/p-c_s-4_u-25_t-136_c-431/WA/5/What-happens-when-light-hits-an-object/How-light-works/Light-up-my-life/Science/
- *Science Experiment: Light Travels*: Students will create a path using index card to prove that light travels in a straight line. To ensure that you are meeting the objective, you need to have students block the light at different points and ask questions about what happens when the light is interrupted. http://www.ducksters.com/science/experiment_light_travel.php
- Students will conduct simple investigations to demonstrate that light travels in a straight line and forms shadows when the light is blocked by an object. http://www.learnnc.org/lp/editions/earth-sun/6624
- Light and Shadow Investigation Lessons: Students will conduct investigations to demonstrate how light travels through transparent, translucent, and opaque objects. Students will explore the idea of shadows. Students will conduct experiments to determine how the shadow changes as the distance between the light source and the object changes. http://gk-12.osu.edu/Lessons/5th%20Grade/Shadows%20Earth%205.pdf

Fifth Grade Performance Indicator:

5.P.5A.2 *Develop and use models* to explain how the amount or type of force (contact and noncontact) affects the motion of an object.

5.P.5A.1 *Use mathematical and computational thinking* to describe and predict the motion of an object (including position, direction, and speed).

Exploration of Motion

Essential Question: How does the motion of objects affected by gravity in our solar system result in a total solar eclipse?

Vocabulary: motion, gravity, inertia, orbit, revolution, rotation

1. **Possible introductory activities:**

Choose from the following resources to support student engagement with the total solar eclipse and transaction with text.

Literary texts:

- Earth, Sun, Moon by Glen Phelan: This is a book published by National Geographic that describes the motion of the earth and moon in relation to the sun.

Videos and other resources:

- *Bill Nye The Science Guy-Gravity (Full Episode)*
  - https://betterlesson.com/community/document/2891454/bill-nye-the-science-guy-gravity-full-episode-mp4
- PBS Learning Media - Does the Moon Really Orbit the Earth?
  - https://scetv.pbslearningmedia.org/resource/does-the-moon-its-okay-to-be-smart/does-the-moon-its-okay-to-be-smart/#.WNXOdPnyvIU

2. Instructional Strategies: The pattern of motion established by the gravitational pull of the sun, earth, and moon results occasionally to create the phenomena known as a total solar eclipse.

- Students participate in demonstrations that simulate microgravity with buoyancy. These were written for sixth to eighth grades, but they could be adjusted to fit the needs of fifth grade. https://aquarius.fiu.edu/education/lesson-plans/buoyancy-lesson-plan_space-school.pdf
- The following site provides activities for elementary and middle-school students. The middle-school activities could be adapted for use at the fifth grade level. Students participate in an activity that demonstrates the effect of gravity on the motion of an object, using marbles and a metal canning ring. Students can also participate in building a planetary model using a quilting hoop, latex sheeting, 3 pedestals, a water balloon, and a marble. http://www.rider.edu/files/tlc-HillsboroughGravityBIMRaytown.pdf
- How Can the Little Moon Hide the Giant Sun? Students will investigate how distance affects the appearance of an object to explain how the smaller moon can block out the much larger sun. http://www.eyeonthesky.org/lessonplans/12sun_littlemoon.html

  Extension: You could also have students compare the distances required for two different balls (a medium sized and a small one) to cover up the larger ball. You could also form a ratio comparing the diameters of the medium and small balls to the distance needed to block the larger ball to explore the relationship between size and distance.

***Science and Engineering Practices**

Support for the guidance, overviews of grade level progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

The SEPs are listed within the different applications of learning in this document but can also be accessed by clicking on the SEP support document link above.

***Cross Cutting Concepts** **(http://www.nap.edu/read/13165/chapter/8)**

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012). The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's. The concepts have applications across all domains of science. Therefore, they can be considered as a way of linking together all science domains.

1. **Patterns:** The National Research Council (2012) states that "observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them" (p. 84). *The earth and moon move in predictable patterns in relationship to the sun and each other. These patterns of motion sometimes result in shadows known as an eclipse. Light moves in a predictable pattern. If an object does not allow light to pass through it the light is blocked producing a shadow.*

2. **Cause and effect: Mechanism and explanation:** The National Research Council (2012) states that "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84). *A solar eclipse is the result of a causal relationship between the earth, sun, and moon. The moon moves between the earth and sun resulting in light from the sun being blocked from the earth resulting in a shadow on the earth's surface. This is known as solar eclipse.*

3. **Scale, proportion, and quantity:** The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *During an eclipse the light from the sun, a much larger object, can be blocked by the moon, a smaller object, due to the greater distance the sun is from the earth.*

4. **Systems and system models:** The National Research Council (2012) states that "defining the system under study-specifying its boundaries and making explicit a model of that system-provides tools for understanding and testing ideas that are applicable

throughout science and engineering" (p.84). *Models can be used to show how motions in the Sun-Earth-Moon system cause Earth phenomena such as a solar eclipse.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Additional Resources:

Should teachers wish to provide students with additional experiences related to the total solar eclipse, the following resources are recommended.

- This website provides a list of books, articles, and websites that can provide teachers and students with information on the total solar eclipse. http://www.astrosociety.org/education/astronomy-resource-guides/eclipse-resource-guide/
- This website provides information on where the total solar eclipse will be able to be seen, when it will occur, how it can be viewed safely, and what an eclipse is. This site provides related SC Curriculum Standards covered through learning about the total solar eclipse and a list of resources for teachers about the solar eclipse. http://thechallengercenter.net/?page_id=1768
- This is the South Carolina State Museum website and provides information on the activities the museum will offer in preparation for the viewing of the total solar eclipse. http://scmuseum.org/eclipse/
- Solar Science: Exploring Sunspots, Seasons, Eclipses, and More, a teacher's resource book by Andrew Fraknoi and Dennis Schatz, contains activities that help teachers prepare their students for the eclipse. http://www.nsta.org/store/product_detail.aspx?id=10.2505/9781941316078

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